

50', with sun's altitude $19^{\circ} 30'$, bearing 94° E., observed a beautiful rainbow, concave, as usual, with apex at 65° , describing an arc of about 50° . In a few moments another bow made its appearance above the original one, of about the same size,

but convex, the limbs making a perfect contact. A moment or two later a lesser bow made its appearance, convex, with an altitude of 40° . Barometer 29.92; air temperature 84° ; wet bulb 76° ; sea 84° ; wind s. by e., force 3."

VERIFICATIONS.

INDICATIONS FOR 24 HOURS IN ADVANCE.

The percentages of verifications of the twice daily indications for September, 1888, as determined from comparison of succeeding telegraphic reports, are given in the table below.

The predictions for districts east of the Rocky Mountains for September, 1888, were made by 1st Lieutenant H. H. C. Dunwoody, 4th Artillery, Acting Signal Officer and Assistant, and those for the Pacific Coast districts were made at San Francisco, Cal., by 2d Lieutenant J. E. Maxfield, Signal Corps; the verifications for all districts were determined by Assistant Professor C. F. Marvin.

Percentages of indications verified, September, 1888.

States.		States.	
Maine	83.3	Tennessee	90.6
New Hampshire	80.3	Kentucky	83.7
Vermont	80.3	Ohio	81.1
Massachusetts	80.5	West Virginia	78.7
Rhode Island	78.9	Indiana	83.3
Connecticut	76.1	Illinois	81.5
Eastern New York	81.5	Lower Michigan	82.1
Western New York	84.5	Upper Michigan	73.7
Eastern Pennsylvania	83.6	Wisconsin	81.3
Western Pennsylvania	80.5	Minnesota	82.0
New Jersey	81.1	Iowa	80.2
Delaware	80.1	Kansas	83.9
Maryland	77.6	Nebraska	83.9
District of Columbia	76.5	Missouri	78.2
Virginia	80.5	Colorado	87.1
North Carolina	85.9	Eastern Dakota	87.7
South Carolina	84.1	Southern California	84.4
Georgia	82.4	Northern California	85.3
Eastern Florida	85.1	Oregon	82.1
Western Florida	75.3	Washington Territory	82.6
Alabama	85.7	By elements: Weather	83.6
Mississippi	85.3	Temperature	79.4
Louisiana	79.9	Monthly percentage of weather and	
Texas	84.4	temperature combined	81.9
Arkansas	85.7		

CAUTIONARY SIGNALS FOR SEPTEMBER.

Statement showing percentage of justifications of wind

signals for the month of September, 1888: Number of cautionary signals ordered, forty-nine; justified, twenty-six. Number of storm signals ordered, twelve; justified, eight. Number of signals ordered for easterly winds, thirty-three; justified as to direction, thirty. Number of signals ordered for westerly winds, twenty-seven; justified as to direction, twenty-five. Number of signals ordered late, three. Number of storms without signals, thirty. Percentage of justifications, 55.1. No cold-wave signals were ordered during the month.

LOCAL VERIFICATIONS.

The following extracts from the published reports of the state weather services for September, 1888, show the percentages of verifications of weather and temperature signals:

Indiana.—Seymore: 78 per cent. of the indications were verified.

Michigan.—Weather signals are now displayed in one hundred and thirty-two towns, and upon the baggage-cars of twenty-six trains of eight of the principal railroads of the state.

The indications are issued at 10 p. m., daily, from the Chief Signal Office, Washington, and are for the twenty-four hours from 7 a. m. to 7 a. m.

The percentages of verifications of these indications for September are as follows (the verifications are taken from reports of displaymen furnished this office monthly): temperature, 81.4 per cent; weather, 79.4 per cent.; temperature and weather, 80.4 per cent.

Weather signals are displayed on the baggage-cars of the following railroads: C. & G. T. R'y; D. G. H. & M. R'y; D. D. G. T. R'y; M. C., main line and branches; C. & W. M. R'y; G. R. & I. R'y; P. H. & N. W. R'y; and the P. O. & P. A. R'y.

Minnesota.—The verifications of weather signals were 83 per cent. for weather and 82 per cent. for temperature.

Nebraska.—The percentages of correct weather predictions for the state were for temperature, 90.5; weather, 90.5; mean, 90.5.

Ohio.—The percentages of verification of weather signals received from Washington and distributed to thirty-two stations were seventy-nine for weather and eighty-seven for temperature.

South Carolina.—The percentages of verifications of weather and temperature predictions for the state were for weather, 85.0; temperature, 83.5.

STATE WEATHER SERVICES.

The following extracts are republished from reports for September, 1888, of the directors of the various state weather services:

ALABAMA.

During the first week rains were continuous in most sections of the state; the last half of the month, however, was comparatively dry and favorable for gathering the cotton that has been opening rapidly, particularly in middle and southern Alabama. The rainfall for the month has not been large—the average being only 0.86 of an inch above the normal—but the unusual precipitation in August made the rain in September injurious to most crops.

The temperature was $3^{\circ}.9$ below the normal, but no very decided cool spells occurred. The fall in temperature was gradual, with slight oscillations.

Summary.

Temperature (in degrees Fahr.).—Monthly mean, 72.4 ; highest monthly mean, 75.7 , at Fort Deposit; lowest monthly mean, 65.7 , at Gadsden; maximum, 90.5 , at Montgomery, 11th; minimum, 35 , at Gadsden, 30th; range for state, 55.5 ; greatest local monthly range, 58 , at Valley Head; least local monthly range, 30 , at Troy.

Precipitation (in inches).—Average for the state, 4.89 ; greatest, 9.96 , at Talladega; least, 1.68 , at Florence.

Wind.—Prevailing direction, northeast.—P. H. Mell, jr., Signal Corps, Auburn, director.

ARKANSAS.

Temperature (in degrees Fahr.).—Monthly mean, 69.9 ; highest monthly mean, 77.6 , at Malvern; lowest monthly mean, 63.9 , at Conway; maximum, 97.0 , at Lead Hill and Texarkana; minimum, 40.0 , at Heber, Graham, and Little Rock; range for state, 57.0 ; greatest local monthly range, 57.0 ; least local monthly range, 22.0 , at Dallas.

Precipitation (in inches).—Average for the state, 1.01 ; greatest, 2.35 , at Devall's Bluff; least, 0.25 , at Graham.—Prof. John C. Branner, Little Rock, director; W. U. Simons, Signal Corps, assistant.

ILLINOIS.

The temperature was equable, but lower than the average of corresponding months in previous years. There were no very cold, neither were there

any hot days. The warmest days were the 8th, 9th, and 10th, and the coldest the 28th and 29th; at no time did the temperature of the air fall below the freezing point, except in the extreme north on the 29th. There were several light frosts, and a killing one on the 29th, but no damage was done to vegetation.

The average temperature for the state was $62^{\circ}.0$, which was $4^{\circ}.4$ below the average of the past ten years. Only once during that period, in 1879, has the monthly mean been lower, when it was $61^{\circ}.7$.

This deficiency of average temperature was evenly distributed over the state; in the northern and central divisions the deficiency was the same— $4^{\circ}.1$, while in the southern it was $4^{\circ}.8$. The maximum temperature was about the average, but the minimum was lower than at any time during the past ten years.

The rainfall has, also, been much below the average of previous years. At only two stations—Peoria and Griggsville—was an excess reported. The monthly average was 1.83 inches below that of the past ten years, and was less than that of any September except in 1883, when it was 1.21 inches.—Col. Charles F. Mills, Springfield, director; James Cassidy, Signal Corps, assistant.

INDIANA.

Cool temperatures prevailed throughout the month, and the mean was nearly 5° below the normal. September, 1871, was as cool as the past month, and September, 1879, only was slightly cooler. The highest temperatures were noted at most stations on the 8th and 11th, and the lowest on the passage of the highest barometric area on the 29th and 30th; at many places heavy killing hoar-frost and ice formed on the mornings of these dates. Abrupt changes in temperature were of rare occurrence, the most noteworthy occurring on the 30th, with the rapid approach of a low barometric area during the latter part of the day, when the temperature rose rapidly, with a sudden fall in barometer.

The precipitation was small, except in the southeast portion of the state, where heavier rains occurred. During the first half of the month but little rain fell, and the number of rainy days was small. The least rain fell in the

northern portion; slightly greater measurements were reported from the central, and the largest in the southern portions, but the amount was every where deficient.

Small hail fell on the 16th at Blue Lick and near Vevay, and on the 28th at Angola. Light hoar-frosts occurred frequently, and heavy killing hoar-frost and ice formed on the 29th and 30th at many places. Thunder-storms occurred on few dates only, but none were accompanied by violent disturbances.

Temperature (in degrees Fahr.).—Monthly mean, 62.0; highest monthly mean, 67.1, at Mount Vernon; lowest monthly mean, 56.6, at Mauzy; maximum, 91.0, at Lafayette, 11th; minimum, 29.0, at Mauzy, 30th; range for state, 50.0; greatest local monthly range, 58.0, at Lafayette; least local monthly range, 38.0, at Seymour.

Precipitation, including melted snow (in inches).—Average for the state, 1.73; greatest, 4.82, at Mauzy; least, 0.40, at Lafayette.

Wind.—Prevailing direction, northeast.—*Prof. H. A. Houston, Lafayette, director; C. F. R. Wappenhans, Signal Corps, assistant.*

IOWA.

The month was fair, cold, and dry, northwesterly winds and calms prevailing.

The mean temperature was 3° 2 below the normal. Since 1870 September has been as cold or slightly colder, five times, namely, in 1883, 1879, 1875, 1873, and 1871, and in 1860 the month was decidedly colder, being 8° 6 below the normal. The coldest days were the 12th and 13th, the 17th and 18th, averaging 10° below normal, and from the 27th to the 29th the temperature averaged 12° below the normal. The 10th and 11th were the warmest days, averaging 6° above the normal. Accordingly, there were no great fluctuations in the temperature. This fact accounts for the absence of early destructive frosts, notwithstanding the low average temperature of the month. The first frost reported occurred during the first two cold days, on the 12th in the northwest and on the 13th in the northeast. The second two cold days (17th and 18th) did not produce any frost, the sky being generally overcast. The third and most noteworthy cold spell, being clear, was marked by moderate frost to the southeastern part of the state on the 28th, while in the northern parts it was heavier. The growing and ripening seasons were favorable in nearly all parts of the state, and the first general frost being late, no notable damage has been done to corn.

Rain has fallen on fourteen days as a whole, though at any given point it fell on only four days in the west and seven days in the east. The total amount of rainfall was comparatively light, amounting to only 59 per cent. of the normal at the central station. Less than one inch fell on the Missouri slope and in central Iowa as far east as Tama county. Over two inches fell locally in Kossuth county and from Muscatine and Johnson to Jackson counties. In the balance of the state the rainfall ranged between one and two inches. The most extended or general rains fell on the 7th, 10th, 14th, and 21st. The month was free from destructive storms.—*Gustavus Hinrichs, Iowa City, director.*

KANSAS.

The mean temperature was below the average, the deficiency being greatest near the central portion of the eastern division. In Shawnee it was 7° 1 below, in Douglas but 0° 4 below, while in Leavenworth it was 8° 5 below. This deficiency diminished southward, being 2° 4 in Woodson and but 1° 9 in Montgomery counties. The deficiency was somewhat uniform in the southern counties, being 2° 3 in Ford, but it almost entirely disappeared in the central-west, while in Gove and Ellis a slight excess appeared.

The first ten days were characterized by high temperature, but during the last twenty days the changes from quite warm to cold and chilly were frequent and rapid, during which there was a constant lowering of the general temperature, culminating in a sharp frost from the 27th to the 29th.

The average precipitation, 0.72, was decidedly deficient. In Woodson county the rainfall reached the September normal. It was probably not far from the normal in the extreme southwestern counties; in all other sections it was deficient. The deficiency amounted to two and one-half inches in the northeastern counties. In Douglas and Miami it amounted to three inches and upwards, but fell to two and a quarter in Shawnee and to but two in Morris county. It rapidly diminished south to Woodson and Allen counties where it was about normal, while south of these counties it rapidly increased again. From Shawnee to the southwest there was a gradual diminution, the deficiency being but 0.46 in Ford. From Shawnee west and northwest it was more marked, Ellsworth, Trego, and Gove showing a total absence of rain, while in Greeley, Thomas, Decatur, and Jewell but little rain fell. In Cloud, Clay, and Graham the deficiency was materially diminished, while it was nearly obliterated in the contiguous portions of Ellis, Russell, Ford, Kiowa, Clark, and Comanche counties.

Summary.

Temperature (in degrees Fahr.).—Monthly mean, 68; highest monthly mean, 76, at Hays City; lowest monthly mean, 61, at Topeka; maximum, 100, at Bunker Hill and Lebo, 9th; minimum, 32, at Allison, 17th; range for state, 68; greatest local monthly range, 67, at Lebo; least local monthly range, 38, at Victoria; greatest daily range, 46, at Tribune, 13th, and at Gibson 21st; least daily range, 5, on the 14th, at Seneca.

Precipitation (in inches).—Average for the state, 0.72; greatest, 3.91, at Yates Centre; least, 0, at Carneiro, Collyer, Gibson, Ellsworth, Wilson, Grainfield, Grinnell, McAllister, Monument, and Oakley.

Wind.—Prevailing direction, south.—*Prof. J. T. Lovewell, Topeka, director; T. B. Jennings, Signal Corps, assistant.*

KENTUCKY.

Temperature (in degrees Fahr.).—Monthly mean 64.8; highest monthly mean, 66.3, at Ashland and Madisonville; lowest monthly mean, 62.1, at Whitesburg; maximum, 87.4, at Frankfort, 9th; minimum, 30.0, at Whitesburg, 30th; range for state, 57.4; greatest local monthly range, 53.1, at Frankfort; least local monthly range, 42.0, at Madisonville.—*Under direction of the State Polytechnic Society, Louisville; Frank Burke, Signal Corps, assistant in charge.*

LOUISIANA.

The meteorological conditions were favorable to all crops after the disastrous storm of August.

During the first two weeks the rainfall was a trifle heavy in the southwestern portion of the state, but being followed by dry clear weather, with warm sunny days and cool nights, the effect on the staples was favorable.

The average temperature was 1° 4 below the normal of the past seventeen years, the deficiency being the same in the northern and southern sections. There were none of the extreme high temperatures reported in former years, the average maxima being slightly above 90° about the 6th and 7th, 11th to 15th, and 21st and 22d. The cool spell occurred during the last three days, when minima ranging from 47° to 60° were reported. The range of temperature was several degrees in excess of a normal daily range for the month in the southern section, and about the normal in the northern section.

There was a deficiency of three inches in the average rainfall as compared with the normal of the past twenty years, being a deficiency of nearly three and one-half inches in the northern section, and nearly two and one-half inches in the southern section. There were but five of the total number of stations that had rainfall in excess of three inches, and fully 40 per cent. of the stations reported less than one inch. The greatest daily rainfall was 1.88 inches at Port Eads on the 1st.

Nearly 50 per cent. of the prevailing winds were from the northeast, and about 33 per cent. from the north.

Summary.

Temperature (in degrees Fahr.).—Monthly mean, 75.6; highest monthly mean, 79.9, at Lake Providence; lowest monthly mean, 71.0, at Vicksburg; maximum, 98, at Liberty Hill, 20th; minimum, 47, at Amite, 29th; range for state, 51; greatest local monthly range, 50, at Liberty Hill; least local monthly range, 22, at Saint Martinsville; greatest daily range, 40, at Liberty Hill, 19th; least daily range, 5, at Saint Martinsville, 5th, 9th, 16th, 30th; mean daily range for the state, 18.2.

Precipitation (in inches).—Average for the state, 1.71; greatest local monthly rainfall, 5.49, at Port Eads; least, trace, at Trinity.—*R. E. Kerkam, Signal Corps, New Orleans, in charge.*

MICHIGAN.

The mean temperature, 56° 7, was 4° 2 below the normal of thirteen years. The temperature was below the normal in all sections, the greatest deficiency occurring in the Upper Peninsula, and the least in the southern section. The mean daily temperature was above the normal on six days and below on twenty-one, being normal on three days. The highest mean daily temperature, 70°, occurred on the 11th, and the lowest, 42°, on the 28th. The highest mean daily temperature for the past thirteen years, 82°, occurred on the 5th, 1881, and the lowest, 42°, on the 28th, 1888. The highest mean monthly temperature, 68° 4, occurred in 1881, and the lowest, 56° 7, in 1888. The maximum temperature for the month, 92°, occurred at Adrian and Highland Station, 11th, and the lowest, 22°, at Lathrop, 1st. Frosts were general on the 13th, 14th, 25th, 26th, and 29th throughout the state, and in the Upper Peninsula were frequent during the early part of the month.

The average precipitation for the month, 2.50 inches, was 0.72 inch below the normal of thirteen years. The precipitation was below the normal in all sections except the northern, where there was an excess of 0.02 inch. The greatest deficiency (1.49 inches) occurred in the southern section. The largest rainfall was reported in the southeastern part of the southern section, in the northern section, and the northwest part of the central section. General rains fell on the 15th, 16th, 17th, 25th, 26th, 28th, and 30th, and local rains on the 4th, 8th, and 29th. Comparing the precipitation for September with the records of the past twelve years, it is found that the largest monthly rainfall, 5.39 inches, occurred in 1879, and the least, 1.63 inches, in 1882.

Summary.

Temperature (in degrees Fahr.).—Monthly mean, 56.7; highest monthly mean, 61.7, at Columbia; lowest monthly mean, 50.5, at Atlantic and Sault Ste. Marie; maximum, 92.0, at Adrian and Highland Station, on the 11th; minimum, 22.0, at Lathrop, on the 1st; range for state, 70.0; greatest local monthly range, 63.0, at Adrian; least local monthly range, 37.1, at Grand Haven; greatest daily range, 55, at Hillman, on the 3d; least daily range, 3, on the 16th, at Manistee.

Precipitation, including melted snow (in inches).—Average for the state, 2.50; greatest, 6.00, at Hart; least, 0.65, at Madison.—*N. B. Conger, Signal Corps, Lansing, director.*

MINNESOTA.

Temperature (in degrees Fahr.).—The mean temperature, 55.2, was about 2.0 below the September normal for Minnesota. The following are some of the local deficiencies as compared with the averages for many years: Saint Vincent, 0.2; Moorhead, 1.2; Minneapolis, 1.5; Duluth, 1.9; Saint Paul, 3.5, and La Crosse, 6.7. September opened warm and pleasant; on the

2d the highest monthly temperatures were noted at a majority of stations, the maximum for the state being 87.0 at Moorhead. On the 4th the temperature fell below normal and it remained cool five or six days. It was quite warm again on the 10th; on that day the mercury went up to 83.5 at Rolling Green, to 81.0 at Mankato, to 79.0 at Minneapolis, and to 76.0 at Lake Winnibigoshish. After this a cool spell was experienced until the 19th. Ordinary temperature now prevailed for a week. The most notable change was a decided fall, to the freezing point and below, on the 28th and 29th. These two days were the coldest of the month at all stations; 22.0 was the monthly minimum recorded at Medford on the 29th.

Precipitation (in inches).—The precipitation was deficient throughout the state. The amount was only 48 per cent. of the average. At Moorhead it was only 31 per cent. of the local average. At La Crosse, 34 per cent.; at Saint Paul, 49 per cent.; at Duluth, 51 per cent., and at Saint Vincent, 73 per cent. Rainfall of an inch, and over, in one day occurred at only two stations during the month, namely, Lake Winnibigoshish Dam, 1.08, 7th, and 1.00 at Farmington on the 14th and 16th.—*Prof. W. W. Payne, Northfield, director; John Healy, Signal Corps, Saint Paul, assistant.*

MISSISSIPPI.

Summary.

Temperature (in degrees Fahr.).—Monthly mean, 73; highest monthly mean, 76, at Waynesborough and Pearlinton; lowest monthly mean, 69, at Corinth and Holly Springs; maximum, 96, at Macon and Hazlehurst on the 6th; minimum, 38, at Corinth, on 30th; range for state, 57; greatest local monthly range, 49, at Corinth; least local monthly range, 31, at Biloxi; greatest daily range, 40, at Meridian on 30th; least daily range, 2, at Pearlinton, on the 23d. The monthly mean temperature for the state, 73, was 3 below the mean for this month last year. The highest temperature occurred at the different stations on the 6th, 14th, and 20th, and the lowest temperature on the last three days of the month.

Precipitation (in inches).—Average for the state, 3.14; greatest, 6.71, at Water Valley; least, 0.37, at Artonish Plantation. The average rainfall for the past month, 3.14, is .03 less than the average for September, 1887, and is about the normal.—*Prof. R. B. Fulton, Oxford, director; M. J. Wright, jr., Signal Corps, assistant.*

MISSOURI.

The mean temperature for the month was 64°.7. The highest temperature reported in the state was 97° at Protom, and the lowest, 28°, at Ironton. The average of maximum temperatures was 88°.9, and the average of minimum temperatures, 40°.2, making an average range of 48°.7. The highest temperatures occurred on the 8th, 10th, 11th, and 20th, and the lowest on the 27th, 28th, 29th, and 30th. Frost occurred on the 28th, extending over the entire state, but did no damage to vegetation. Very light frost was also reported on the 13th, 16th, and 30th, in a few localities.

The average precipitation was 1.12 inches, which was considerably below the September normal. The greatest amount reported was 2.59 inches, at Glasgow, and the least, 0.20 inches, at Saint Charles.

In the state, as a whole, rain fell on 22 days, although no more than six days of rain occurred in any one place. The rains were most general on the 8th, 14th, 15th, 16th, 21st, and 22d. Thunder and lightning occurred on all these dates, and on the 7th, 11th, and 12th; the thunder-storms were severest on the 14th and 21st.—*Prof. Francis E. Nipher, Saint Louis, director; G. A. Weber, Signal Corps, assistant.*

NEBRASKA.

The month has been one of the driest on record, with both higher and lower temperatures than for any previous September, and with the mean temperature about the normal.

The mean temperature was 64°.6, the maximum 100° at Culbertson, and the minimum 26° at Ravenna. The maximum has never been higher than 99° nor the minimum lower than 28° in previous Septembers. Light frosts occurred on the 15th, 16th, and 17th, and a killing frost on the 29th.

Only two stations in the state, Sargent and Red Willow, report over an inch of rain. Hay Springs and Palmer report no rain and generally there has been almost none.—*Prof. Goodwin D. Swezey, Crete, director; G. A. Loveland, Signal Corps, assistant.*

NEW ENGLAND METEOROLOGICAL SOCIETY.

Summary.

Temperature (in degrees Fahr.).—Monthly mean, 57.7, (eighty-seven stations); highest monthly mean, 62.7, at Nantucket; lowest monthly mean, 51.4, at Berlin Falls; maximum, 88, at Colchester, 13th; minimum, 18, at Berlin Falls, 7th; range for New England, 70; greatest local monthly range, 60, at Lake Cochituate and Colchester; least local monthly range, 34, at Nantucket; greatest daily range, 46, at Stratford, 7th; least daily range, 1, at Lowell, on the 21st.

Precipitation, including melted snow (in inches).—Average for New England, 8.29 (one hundred and twenty-nine stations); greatest, 18.43, at Northampton; least, 3.77, at Berlin Mills.

Wind.—Prevailing direction, southwest (twelve stations).—*Prof. William H. Niles, Boston, Mass., president; Prof. Winslow Upton, Providence, R. I., secretary; Park Morrill, Signal Corps, assistant.*

NEW JERSEY.

The mean temperature for the month, 68°.1, was 2°.2 below the average determined from past records of fifty-two stations.

The average rainfall for the state, 7.09 inches, is 3.20 inches above the average determined from past records of forty-nine stations. The largest amount reported was 10.65 inches at Oceanic, and the smallest 3.75 inches at Bridgeton. The average number of days upon which rain fell was 12.1.

Summary.

Temperature (in degrees Fahr.).—Monthly mean, 63.1; highest monthly mean, 68.0, at Trenton; lowest monthly mean, 59.3, at Tenaflly; maximum, 96.0 at Toms River, 22d; minimum, 30.0, at Tenaflly, 30th; range for state, 66.0; greatest local monthly range, 61.0, at Toms River; least local monthly range, 33.0, at Ocean City; greatest daily range, 38.5, at Freehold, 8th; least daily range, .00, at Ocean City, 6th.

Wind.—Prevailing direction, northeast.—*Prof. George H. Cook, New Brunswick, director; E. W. McGann, Signal Corps, assistant.*

NEW YORK.

The highest temperature recorded was 84° on the 18th at New York City, and on the 9th at Palmyra; the lowest, 29°, on the 30th, at Utica; the mean temperature for the state was 54°. Nearly all the stations report the 9th as the hottest day, and the 29th and 30th as the coldest days. The temperature of the month has been generally low, except at Palmyra, where it has been 2° warmer than the normal.

The average precipitation for the state was 4.22 inches, being more than the normal at all places, except at Rochester and Humphrey, where it was less. General rains occurred on the 8th, 16th, and 17th. The heaviest rainfalls were as follows: New York City, Ardenia, and White Plains, over 7 inches, and at Boyd's Corners more than 10 inches. Hail fell at several places on the 29th and 30th. Snow was reported from a few stations on the 30th. Frosts occurred generally on the 6th, 7th, 29th, and 30th.—*E. A. Fuertes, Ithaca, director; I. W. Brewer, Signal Corps, assistant.*

NEVADA.

Temperature (in degrees Fahr.).—The temperature was generally above the normal. The highest reported was 112.1 at El Dorado Canyon on the 14th, and the lowest, 30.0, at Pyramid Lake, on the 26th. Ice formed at Dayton on the night of the 4th. The mean temperature at Carson City was the highest recorded in nine years by nearly five degrees. Most of the stations reported a maximum between 90 and 96. Beowawe reports 98 on the 4th, Hot Springs 100 on the 13th, and Mill City 104 on the 2d. The hot spell was not confined to any portion of the state, and lasted from the 1st until the storm of the 15th, after which the temperature was about the average for the month. It is generally reported that this was the driest and the hottest season ever experienced in Nevada, and the Carson river has never been so low.

Precipitation (in inches).—The rainfall was generally above the average in the western and central part of the state. The periods of rainy weather were from the 14th to 18th, 23d to 24th, and on the 30th; 2.11 inches fell at Pyramid Lake between the evening of the 21st and that of the 26th. The principal storm of the month traveled slowly from the west, and gave a fall of 0.43 at Verdi on the 12th, 0.36 at Carson, 0.46 at Lewers' Ranch, 0.56 at Dayton on the 14th, 0.70 at Eureka on the 17th, and 0.82 at Ely on the 18th.

Wind.—Prevailing direction, northwest.—*Prof. Charles W. Friend, Carson City, director; E. H. Thompson, Signal Corps, assistant.*

NORTH CAROLINA.

Temperature (in degrees Fahr.).—Monthly mean, 68.8; normal, 70.0; departure from the normal, -1.2; highest monthly mean, 74.2, occurred at Southport; lowest monthly mean, 64.3, at Knoxville, Tenn.; highest, 97.0, at Kitty Hawk, 1st; lowest, 29.0, at Lenoir, 30th; range for state, 68.0; mean monthly range, 48.6; greatest monthly range, 58.1, at Kitty Hawk; least monthly range, 33.6, at Hatteras; mean daily range, 14.4; highest mean daily range at Chattanooga, Tenn., and lowest mean daily range, 8.2, at Hatteras.

Precipitation (in inches).—mean, 8.56; normal, 4.76; departure from the normal, 3.80; highest monthly rainfall, 10.88, at Raleigh; lowest monthly rainfall, 4.42, at Chattanooga, Tenn.

Wind.—Prevailing direction, northeast.—*Dr. Herbert B. Battle, Raleigh, director; H. McP. Baldwin, Signal Corps, assistant.*

OHIO.

Temperature (in degrees Fahr.).—The mean temperature of the northern section was 58.9; of the middle section, 60.0, and of the southern section, 61.9. These are 3.4, 4.0, and 3.9, respectively, below the six year means for the sections. The mean temperature for the state, 64, was 3.7 below the average, and was the lowest mean temperature for the month on record in the bureau. The maximum temperature, 91.7, at Wauseon, on the 11th, was the lowest maximum on record for September. The minimum was 26 at the Ohio State University on the 30th. The mean daily range of temperature, 20.5, was the lowest on record for the month. Killing frosts were reported from Ellsworth on the 13th; Wauseon, 14th; North Lewisburg and Ohio State University on the 28th; Dayton, Bangorville, Ripley, and Ohio State University on the 29th and 30th; and Cincinnati, Yellow Springs, Columbus, Logan, and Wooster on the latter date.

Precipitation (in inches).—General rains fell in all sections on the 7th, 8th, 15th, and 16th. Local rains in all sections on the 20th; in the northern section on the 12th, 19th, 26th, 27th, 28th, 29th, and 30th; and in the southern section on the 1st, 3d, 4th, and 28th. The mean rainfall in the northern section was 2.84, and in the middle section 1.43; these are 0.15 and 1.70, respectively, below the averages for the sections. The mean for the southern section, 2.54, was .01 above the average. The mean for the state, 2.27, was

0.61 below the six year average, leaving a deficiency of this amount in the yearly rainfall to October 1st.—*Prof. B. F. Thomas, Columbus, director; Lieut. Charles E. Kilbourne, secretary; C. M. Strong, Signal Corps, assistant.*

PENNSYLVANIA.

Temperature (in degrees Fahr.).—The temperature for September, like that of July and August, was below the normal. At the end of the month the season was about one week late. The mean temperature, 59.0, determined from fifty-two stations, was 2 below the average. The highest temperatures were Emporium, Coatesville, McConnellsburg, Lancaster, New Bloomfield, and Columbus, 84. These occurred on the 9th and 12th. The lowest were Dyberry, 29; Honesdale, Somerset, Bernice, and Columbus, 30. These occurred on the 29th and 30th. The following stations reported the highest mean monthly temperatures: Pottstown, 64.3; Coatesville, 64.6; Carlisle, 63.7; and Catawissa, 63.5. Lowest: Somerset, 53.3; Phillipsburg, 53.5; Bernice, 54.9; Dyberry, 54.5; and Smethport, 55. Frosts were quite general on the 29th and 30th.

Precipitation (in inches).—The average monthly rainfall for the state was 4.84 inches, which is about 1.35 more than the average. It was nearly normal west of the Susquehanna River. The largest monthly totals occurred at Bethlehem, 10.93; Quakertown, 9.36; and Girardville, 8.18. The lowest at Pittsburgh, 1.77; and Wellsboro, 1.75. A number of stations reported light snow on the 29th and 30th.—*Under direction of the Franklin Institute, Philadelphia; T. F. Townsend, Signal Corps, assistant, in charge.*

SOUTH CAROLINA.

The mean temperature as far as reported was 69°.6, being 2°.6 less than the record for September, 1887. In most instances the highest maximum temperature occurred on the 1st, and the minimum on the 30th.

The mean depth of rainfall was 9.86 inches, while the record for September, 1887, shows a mean depth of 1.12 inches. The greatest amount of precipitation occurred at Newberry, where a fall of 17.90 inches was recorded. The rainfall in the early part of the month was general and in many places excessive, causing considerable loss to the farming interests.—*Hon. A. P. Butler, Columbia, director; H. C. Seymour, Signal Corps, assistant.*

TENNESSEE.

The only notable features of the month were the low temperature which prevailed during the last few days, resulting in frosts, and the unusual rainfalls on the 7th, 15th, and 22d. There were but few electrical disturbances, and no very high winds. Altogether the month was rather a pleasant one.

Temperature (in degrees Fahr.).—The mean temperature was 64.2, five less than the September mean of the past years, and the lowest during that period. The highest local mean was 69.4, at Savannah, and the lowest, 62.0, at Fostoria; the highest temperature reported was 90, on the 5th, at Fayetteville, and was the lowest maximum for September during the past six years; the lowest temperature reported was 30, on the 30th, at Fostoria and Lawrenceburg, and was the lowest September minimum during the period above named; the maximum temperature was recorded generally about the 14th and 20th and the minimum, with two or three exceptions, on the 30th; the daily ranges of temperature were generally below the normal.

Precipitation (in inches).—The mean depth of rainfall was 3.38, more than half an inch above the average for six years, and the greatest for that period, except in 1885, when 3.80 fell; of this amount the eastern division received an average of about four and a quarter inches, the middle division about four inches, while the western division received an average of less than an inch and a half. From the 1st to the 7th, inclusive, there were daily rains, mostly light, until the last-named date, on which the heaviest rain of the month occurred, averaging about an inch of rainfall for the entire state. This rain was particularly heavy in the middle division, where the average amounted to 1.67. The rains of the 15th and 22d were also heavy, but with these exceptions very little fell during the last two decades of the month. The greatest rainfall was 6.73 at Riddleton, and the least was 0.40 at McKenzie. The greatest in twenty-four consecutive hours was 3.67, on the 7th, at Riddleton. On this date other heavy rains were reported, as at Austin, 3.00; Florence station, 2.33; Hohenwald, 2.79; Kingston Springs and Ashwood, each 1.50; Nunnely, 2.01; Waynesborough, 1.47; and Savannah, 1.35. There were fifteen days on which no measurable rainfall was reported.

Wind.—prevailing direction, north and west.—*J. D. Plunket, M. D., Nashville, director; H. C. Bate, Signal Corps, assistant.*

NOTES AND EXTRACTS.

DEPTH OF EVAPORATION IN THE UNITED STATES.

By T. RUSSELL, Assistant Professor, Signal Service.

It has been proposed to find the depth of evaporation that takes place inside the thermometer shelters at the various Signal Service stations. For this purpose the relation has been determined between the evaporation observed at a few stations with Piche evaporimeters and the condition of the air as to dryness, deduced from the tri-daily readings of the whirled, wet, and dry-bulb thermometers. The relation between the evaporation as given by a Piche instrument, and what it would be from a water surface, has been determined by comparisons at the Signal Office in Washington of the amounts of evaporation from the Piche with that from a cylindrical tin vessel 6.55 centimetres in diameter and 1.3 centimetres in depth, filled to the brim with water. The amounts of evaporation were obtained by weighings on successive days made to the nearest hundredth of a gramme by means of a fine balance.

The results of the determinations of the evaporation for the whole country are contained in Table III, which gives the computed depth in inches for each month and year. The chart, No. vi, is based on this table. The lines join places having equal annual depth of evaporation.

It is believed that these figures represent, approximately, the evaporation that takes place from the surface of ponds, rivers, reservoirs, and lakes in the vicinity of the Signal Service stations.

This belief is based principally on the results of observations of evaporation and determinations of the humidity of the air from wet and dry-bulb thermometer readings made at Nukuss, from May to October, 1875, under the direction of the Central Physical Observatory at St. Petersburg, and reported upon by Ed. Stelling in Band viii, No. 3, of Wild's "Repertorium für Meteorologie," 1882.

The observations were made by weighings of the evaporation from the surface of a pond by means of a vessel containing water immersed in the pond. Observations were also made of the evaporation from a water vessel on land, exposed in the sunshine, and from a similar vessel in a thermometer shelter. The wet and dry-bulb thermometers were read every two hours throughout the day during the whole time for five months that the evaporation observations were made. The results of the work were, as given by Stelling, that the humidity results, obtained from wet and dry-bulb readings with suitable constants, represented the evaporation from the surface of the pond within 15 per cent., and that the evaporation from the vessel in the sunshine for the average of five months was about 10 per cent. greater than that from the vessel in shelter. For one month, however—September—the evaporation in the shelter was about 3 per cent. greater than that in sunshine. The air is very dry at Nukuss. The depth of evaporation in June, in the sunshine, the greatest in five months, was 14.9 inches.

Observations of evaporation in Signal Service shelters, from water dishes, would be very difficult. There are many difficulties in the way of observing

evaporation from water dishes in the open air. The falling of rain splashes the water from the vessel or adds to it. When the temperature of the air is below freezing it is impossible to get a fair measure of evaporation for a great part of the time, on account of the drifting snow. For the winter season the evaporation calculated by an empirical process from the dryness of the air, such as has been used here for the whole year round, is probably more accurate than any results of direct measurement.

It is acknowledged that the results of direct measurement of evaporation from water dishes, by weighing, would, on the whole, give a more satisfactory determination of the depth of evaporation than the process here resorted to, but the expense of procuring balances, and the great labor entailed on the men at stations by the method, forbid its use.

Even after evaporation is obtained from dishes it is doubtful what it represents. Under the same circumstances of temperature and dryness of air, different shaped vessels will give different results for the depth of evaporation, presumably on account of the varying facility with which the vessel takes the temperature of the air, which depends on its shape, the material of which it is made, and its absolute size. A cylindrical vessel of the same bulk as a rectangular one exposes less surface to the air, and as the vessel gains its heat by contact with the air, it will usually not be at the same temperature as the rectangular one. Evaporation from the surface tends to lower the temperature, and the amount of lowering depends on the relation between the surface and the volume of water. At 8 p. m., as observed at Nukuss, this lowering of the temperature of the water in vessels amounted, on the average in June, to 9°.9 Fahr.

But greater than all other things, in its effects on the depth of evaporation from vessels, is the effect of the depth of the water surface below the rim of the vessel. In the case of a vessel of circular section 2.5 inches in diameter, the evaporation, when brimfull, is about 50 per cent. greater than when the water surface is 0.3 of an inch below the rim.

Even if a satisfactory size and shape of vessel for observation of evaporation could be settled upon, it is very doubtful how nearly evaporation from it would represent the actual evaporation from the surface of a neighboring pond or river, owing to the uncertainty of the effect of the wind. Wind promotes evaporation powerfully, as will be seen further on. But, by means of wind velocities, as measured by anemometers high up in the air, it is hard to estimate the effects of wind on evaporation from a pond or river sheltered by trees or high banks.

For any particular place the most satisfactory way to obtain the depth of evaporation would be by a special investigation for that place.

The Piche evaporimeter (see figure) consists of a glass tube 9 inches long and 0.4 of an inch internal diameter. The top end is closed and has an eye for suspending the instrument. The tube is filled with water and on the open end a paper disk 1.2 of an inch in diameter is placed and held in position by a brass fixture sliding easily in a collar along the tube. Water is supplied to